FR Practice #2 (2002B #2, 10 points)

2. A rigid 8.20 L flask contains a mixture of 2.50 moles of H_2, 0.500 mole of O_2, and sufficient Ar so that the partial pressure of Ar in the flask in 2.00 atm. The temperature is 127°C.

   a. Calculate the total pressure in the flask. (3 points)

   b. Calculate the mole fraction of H_2 in the flask. (2 points)

   c. Calculate the density (in g L^{-1}) of the mixture in the flask. (2 points)

   The mixture is ignited by a spark, and the reaction represented below occurs until one of the reactants is entirely consumed.

   $$2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(g)$$

   d. Give the mole fraction of all species present in the flask at the end of the reaction. (3 points)

(3 pt) (a) $P_{H_2} = \frac{n_{H_2}RT}{V} = \frac{(2.50\ mol)(0.08206\ \frac{L \cdot atm}{mol \cdot K})(400.\ K)}{8.20\ L} = 10.0\ atm$ (1 pt)

$P_{O_2} = \frac{n_{O_2}RT}{V} = \frac{(0.500\ mol)(0.08206\ \frac{L \cdot atm}{mol \cdot K})(400.\ K)}{8.20\ L} = 2.00\ atm$ (1 pt)

$P_{tot} = P_{H_2} + P_{O_2} + P_{Ar} = 10.0 + 2.0 + 2.0 = \boxed{14.0\ atm}$

(2 pt) (b) $mol_{Ar} = \frac{PV}{RT} = \frac{(2.00\ atm)(8.20\ L)}{(0.08206\ \frac{L \cdot atm}{mol \cdot K})(400.\ K)} = 0.500\ mol\ Ar$ (1 pt)

$\chi_{H_2} = \frac{2.50\ mol\ H_2}{2.50\ mol\ H_2 + 0.500\ mol\ O_2 + 0.500\ mol\ Ar} = \frac{2.50\ mol}{3.50\ mol} = \boxed{0.714}$

(2 pt) (c) $2.50\ mol\ H_2 \times \frac{2.016\ g\ H_2}{1\ mol\ H_2} = 5.04\ g\ H_2$

$0.500\ mol\ O_2 \times \frac{32.0\ g\ O_2}{1\ mol\ O_2} = 16.0\ g\ O_2$

$0.500\ mol\ Ar \times \frac{40.0\ g\ Ar}{1\ mol\ Ar} = 20.0\ g\ Ar$

$total\ mass = 5.04 + 16.0 + 20.0 = 41.0\ g$ (1 pt)

$density = \frac{mass}{volume} = \frac{41.0\ g}{8.20\ L} = \boxed{5.00\ g/L}$ (1 pt)

d.) $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$

2.50	0.500	0
-1.00	-0.500	+1.00
1.50	∅	1.00

$\Rightarrow$ total moles = 1.50 mol + 1.00 mol + 0.500 mol
after rxn H_2 H_2O Ar
= 3.00 mol total (1 pt)

$\chi_{H_2} = \frac{1.50 \text{ mol } H_2}{3.00 \text{ mol}} = \boxed{0.500}$

$\chi_{Ar} = \frac{0.500 \text{ mol Ar}}{3.00} = \boxed{0.167}$

$\chi_{H_2O} = \frac{1.00 \text{ mol } H_2O}{3.00} = \boxed{0.333}$

} 1 pt for any two